

## **Appendix D**

### **Calculation of Groundwater Risk-Based Concentrations**

# Appendix D

## Calculation of Groundwater Risk-Based Concentrations

### D.1 INTRODUCTION

The purpose of this appendix is to describe the methodology and approach for development of groundwater risk-based concentrations (RBCs) that will be used to develop a set of waste soil concentration limits based on meeting the groundwater remedial action objectives (RAOs) of not exceeding maximum contaminant levels (MCLs) or RBCs in groundwater downgradient of the INEEL CERCLA Disposal Facility (ICDF). RBCs were developed for the contaminants in the design inventory, based on a residential exposure scenario.

### D.2 EXPOSURE SCENARIO

Adult and child residents located downgradient of the ICDF could potentially be exposed to site-related constituents in groundwater through ingestion, dermal contact, and inhalation of volatiles during showering or other household activities. The residential exposure scenario assumes a groundwater ingestion rate of 2 liters per day for adults and 1 liter per day for children, and an exposure frequency of 350 days per year, over a 30 year duration (6 years for a child plus 24 years for an adult).

RBCs for the residential exposure scenario are based on a target excess lifetime cancer risk of  $1 \times 10^{-4}$  for carcinogens or a hazard quotient of 1 for noncarcinogens.

### D.3 EXPOSURE ASSUMPTIONS

Exposure assumptions for development of groundwater RBCs for the residential scenario are summarized in Table D-1 at the end of this appendix.

#### **D.3.1 Equations for Non-Radiological Groundwater Risk-Based Concentrations**

Groundwater RBCs were calculated in accordance with EPA guidance (EPA 1991). The following subsections provide the equations used to calculate the RBCs for carcinogens and noncarcinogens.

##### **D.3.1.1 Noncarcinogens**

Equation (D-1) was used to calculate the groundwater for noncarcinogenic chemicals:

$$RBC(\text{mg/L}) = \frac{THI \times ATN \times 365 \text{ days/year}}{EF \times \left[ \left( \frac{1}{RfD_o} \times IR_{adj} \right) + \left( \frac{1}{RfD_d} \times CF \times SA_{adj} \times Kp \right) + \left( \frac{1}{RfD_i} \times INH_{adj} \times VF \right) \right]} \quad (\text{D-1})$$

##### **D.3.1.2 Carcinogens**

Equation (D-2) was used to calculate the groundwater risk-based concentrations for carcinogenic chemicals:

$$RBC(mg / L) = \frac{TR \times ATC \times 365 \text{ days / year}}{EF \times \left[ \left[ SF_o \times IR_{adj} \right] + \left[ SF_d \times CF \times SA_{adj} \times Kp \right] + \left[ SF_i \times INH_{adj} \times VF \right] \right]} \quad (D-2)$$

where

$$IR_{adj} = \left( \frac{IR_a \times ED_a}{BW_a} \right) + \left( \frac{IR_c \times ED_c}{BW_c} \right)$$

and

$$SA_{adj} = \left( \frac{SA_a \times ET_a \times ED_a}{BW_a} \right) + \left( \frac{SA_c \times ET_c \times ED_c}{BW_c} \right)$$

and

$$INH_{adj} = \left( \frac{INH_a \times ED_a}{BW_a} \right) + \left( \frac{INH_c \times ED_c}{BW_c} \right).$$

Chemical-specific dermal permeability coefficients (Kps) are derived from the *Dermal Exposure Assessment: Principles and Applications* and the *Risk Assessment Guidance for Superfund Volume I: Human Health Evaluation Manual Supplemental Guidance Dermal Risk Assessment Interim Guidance* (EPA 1992; EPA 1998).

Volatile constituents considered for the inhalation pathway are operationally defined as those constituents with a Henry's Law Constant greater than  $10^{-5}$  atm-m<sup>3</sup>/mole and a molecular weight less than 200 grams per mole (EPA 1991).

### **D.3.2 Equations for Radiological Groundwater Risk-Based Concentrations**

Groundwater RBCs were calculated in accordance with EPA guidance (EPA 1991). Only the carcinogenic effects of radionuclides are considered for this evaluation. The following subsections provide the equations used to calculate the RBCs for radiological parameters.

#### **D.3.2.1 Carcinogens**

Equation (D-3) was used to calculate the groundwater RBCs for carcinogenic chemicals:

$$RBC(pCi / L) = \frac{TR}{EF \times \left[ \left[ SF_o \times IR_{adj} \right] + \left[ SF_o \times CF \times SA_{adj} \times Kp \right] \right]} \quad (D-3)$$

where

$$IR_{adj} = (IR_a \times ED_a) + (IR_c \times ED_c)$$

and

$$SA_{adj} = (SA_a \times ET_a \times ED_a) + (SA_c \times ET_c \times ED_c).$$

Chemical-specific dermal permeability coefficients (Kps) for radiological parameters were not available. However, radiological constituents were predicted to behave similarly to metals in groundwater, therefore Kp values for metals were used as surrogate values. Kp values for metals are derived from the *Risk Assessment Guidance for Superfund Volume I: Human Health Evaluation Manual Supplemental Guidance Dermal Risk Assessment Interim Guidance* (EPA 1998).

None of the radiological parameters were identified as volatile constituents, therefore the inhalation pathway was not evaluated.

## D.4 Toxicity Values

The primary source of toxicity values is the EPA's Integrated Risk Information System (IRIS) database. If a toxicity value is not available from IRIS, then Health Effects Assessment Summary Tables (HEAST) were used. Toxicity values (i.e., cancer slope factors, inhalation slope factors, oral reference doses, and inhalation reference doses) used to calculate the groundwater RBCs are presented at the end of this appendix in Table D-2 (for non-radiological parameters) and Table D-3 (for radiological parameters) and were obtained from the following sources:

- The Integrated Risk Information System (IRIS), a database available through the EPA National Center for Environmental Assessment (NCEA). IRIS, prepared and maintained by EPA, is an electronic database containing health risk and EPA regulatory information on specific chemicals (EPA 2001).
- The Health Effects Assessment Summary Tables (HEAST), provided by the EPA Office of Solid Waste and Emergency Response (EPA, 1997b) is a compilation of toxicity values published in various health effects documents issued by EPA.
- The U.S. EPA Region IX Preliminary Remediation Goal Table (November 2000) at [www.epa.gov/docs/region09/waste/sfund/prg/index.html](http://www.epa.gov/docs/region09/waste/sfund/prg/index.html).

Where available, appropriate surrogate toxicity factors were used for detected chemicals without toxicity factors. 2-nitroaniline was selected as a surrogate for 3-nitroaniline and 4-nitroaniline; 4-nitrophenol was selected as a surrogate for 2-nitrophenol; acenaphthene was selected as a surrogate for acenaphthylene; PCB aroclor 1260 was selected as a surrogate for PCB aroclor 1268; pyrene was selected as a surrogate for benzo(g,h,i)perylene. Use of surrogate toxicity factors assumes the toxicity of structurally similar compounds is equivalent, which may result in an under- or overestimate of risks at the site.

Calcium, magnesium, potassium, and sodium are chemicals considered to be essential nutrients necessary for human nutrition.

RBCs were not calculated for the following nonradiological chemicals because appropriate surrogate toxicity values could not be identified:

- 3-methyl butanal, 4-bromophenyl-phenyl ether, 4-chloro-3-methylphenol, 4-chlorophenyl-phenyl ether, bis (2-chloroethoxy)methane, 1,1,3,4-tetrachlorobutane, 3,4-dimethyl decane, diacetone alcohol, dimethyl disulfide, eicosane, ethyl cyanide, famphur, 2,6,10,15-tetra heptadecane, isopropyl alcohol/2-propanol, mesityl oxide, 2,3,7-trimethyl octane, o-toluene sulfonamide, 2,6-bis(1,1-dimethyl) phenol, p-toluenesulfonamide, tributylphosphate, 4,6-dimethyl-undecane, chloride, lead, nitrate, nitrate/nitrite-N, nitrite, phosphorus, sulfate, sulfide, terbium, ytterbium, and zirconium.

RBCs were not calculated for the following radiological chemicals because slope factors were not available:

- Ac-225, Am-245, At-217, Ba-136m, Bi-212, Cm-241, Cm-242, Cm-243, Cs-134, Cs-135, Cs-136, Cs-137, Eu-154, Ln-114m, Np-235, Po-213, Rb-87, Rh-103m, Se-79, Tb-161, Th-234, and Tl-208.

Lack of appropriate toxicity factors for the above chemicals may result in an underestimation of risks at the site.

## D.5 CALCULATION OF CUMULATIVE RBCS

Cumulative RBCs were calculated for each chemical following the development of individual RBCs. Each chemical with an RBC was categorized as either a carcinogen or noncarcinogen. For those chemicals that are considered as both a carcinogen and noncarcinogen, the lower of the two RBCs was selected. Cumulative RBCs for carcinogenic chemicals were derived by dividing the individual RBC for each carcinogen by the total number of carcinogenic chemicals identified. Similarly, cumulative RBCs for noncarcinogens were derived by dividing the individual RBC for each noncarcinogen by the total number of noncarcinogens identified. A summary of the groundwater RBCs developed for non-radiological and radiological constituents are presented at the end of this appendix in Tables D-4 through D-6.

Table D-1. Summary of Exposure Assumptions.  
 Fate and Transport Modeling Results and Summary Report  
 ICDF

Parameter	Symbol	Residential	Source
Groundwater Risk-Based Concentration (mg/L or pCi/L)	RBC <sub>GW</sub>	Calculated	--
Target Excess Lifetime Cancer Risk	TR	1.00E-04	--
Target Hazard Index	THI	1	--
Exposed individual	--	Adult & Child	--
Body weight - adult (kg)	BW <sub>a</sub>	70	a
- child (kg)	BW <sub>c</sub>	15	a
Groundwater ingestion rate - adult (mg/day)	IR <sub>a</sub>	2	a
- child (mg/day)	IR <sub>c</sub>	1	a
Age-adjusted water intake factor (L-year/kg-day)	IR <sub>adj</sub>	1.09	--
Inhalation rate - adult (m <sup>3</sup> /day)	INH <sub>a</sub>	20	b
- child (m <sup>3</sup> /day)	INH <sub>c</sub>	10	b
Age-adjusted Inhalation Rate (m <sup>3</sup> -year/kg-day)	INH <sub>adj</sub>	1.09	--
Volatilization factor (L/m <sup>3</sup> )	VF	0.5	d
Exposed body parts - adult		Entire Body	--
- child		Entire Body	--
Exposed skin surface area - adult (cm <sup>2</sup> )	SA <sub>a</sub>	18000	c
- child (cm <sup>2</sup> )	SA <sub>c</sub>	6600	c
Age-adjusted surface area (cm <sup>2</sup> -hr-yr/kg)	SA <sub>adj</sub>	1992	--
Exposure time (hour/event) - adult	ET <sub>a</sub>	0.25	c
- child (cm <sup>2</sup> )	ET <sub>c</sub>	0.17	c
Showering event frequency (event/day)		1	c
Dermal permeability constant (cm/hour)	Kp	Chemical-specific	see Table
Exposure frequency (days/year)	EF	350	a
Years exposed		30	a
Years over which exposure is averaged - adult	ATN <sub>a</sub>	Noncancer - 24	a
- child	ATN <sub>c</sub>	Noncancer - 6	a
	ATC	Cancer - 70	a

Notes:

- a. Human Health Evaluation Manual, Supplemental Guidance: Standard Default Exposure Factors. OSWER Directive No. 928.6-03, March 25, 1991.
- b. USEPA Exposure Factors Handbook Volume I, General Factors. Office of Research and Development, EPA/600/P-95/002Fa, August 1997.
- c. Risk Assessment Guidance for Superfund Volume I: Human Health Evaluation Manual Supplemental Guidance Dermal Risk Assessment Interim Guidance. Office of Emergency and Remedial Response. Peer Consultation Workshop Draft. November 6, 1998.
- d. Andelman, J.B. 1990. Total Exposure to Volatile Organic Chemicals In Potable Water. N.M. Ram, R.F. Christman, K.P. Cantor (eds). Lewis Publishers.

Table D-2. Summary of Toxicity Factors for Non-Radiological Parameters.

Fate and Transport Modeling Results and Summary Report

ICDF

Chemical Name	Weight of Evidence Class	SFo	RfDo	SFi	RfDi	Source	Kp
		(mg/kg-day) <sup>-1</sup>	Source	(mg/kg-day)	day)		
1,1,1-Trichloroethane	D	--	--	2.00E-02	e	--	2.86E-01
1,1,2,2-Tetrachloroethane	C	2.00E-01	a	6.00E-02	e	2.03E-01	6.00E-02
1,1,2-Trichloroethane	C	5.70E-02	a	4.00E-03	a	5.60E-02	4.00E-03
1,1-Dichloroethane	C	--	--	1.00E-01	b	--	1.43E-01
1,1-Dichloroethene	C	6.00E-01	a	9.00E-03	a	1.75E-01	9.00E-03
1,2,4-Trichlorobenzene	D	--	--	1.00E-02	a	--	5.70E-02
1,2-Dichlorobenzene	D	--	--	9.00E-02	a	--	5.71E-02
1,2-Dichloroethane	B2	9.10E-02	a	3.00E-02	e	9.10E-02	1.40E-03
1,2-Dichloroethene (total)	--	--	--	1.00E-02	b	--	1.00E-02
1,3-Dichlorobenzene	D	--	--	9.00E-04	e	--	9.00E-04
1,4-Dichlorobenzene	C	2.40E-02	b	3.00E-02	c	2.20E-02	2.29E-01
1,4-Dioxane	B2	1.10E-02	a	--	--	1.10E-02	d
2,4,5-Trichlorophenol	--	--	--	1.00E-01	a	--	1.00E-01
2,4,6-Trichlorophenol	B2	1.10E-02	a	--	--	1.09E-02	a
2,4-Dichlorophenol	--	--	--	3.00E-03	a	--	3.00E-03
2,4-Dimethylphenol	--	--	--	2.00E-02	a	--	2.00E-02
2,4-Dinitrophenol	--	--	--	2.00E-03	a	--	2.00E-03
2,4-Dinitrotoluene	B2	--	--	2.00E-03	a	--	2.00E-03
2,6-Dinitrotoluene	B2	--	--	1.00E-03	b	--	1.00E-03
2-Butanone	D	--	--	6.00E-01	a	--	2.86E-01
2-Chloronaphthalene	--	--	--	8.00E-02	a	--	8.00E-02
2-Chlorophenol	--	--	--	5.00E-03	a	--	5.00E-03
2-Hexanone	--	--	--	4.00E-02	c	--	1.40E-03
2-Methylnaphthalene	--	--	--	2.00E-02	c	--	--
2-Methylphenol	C	--	--	5.00E-02	a	--	5.00E-02
2-Nitroaniline	--	--	--	5.71E-05	d	--	5.71E-05
2-Nitrophenol	--	--	--	8.00E-03	g	--	8.00E-03
3,3'-Dichlorobenzidine	B2	4.50E-01	a	--	--	4.50E-01	d
3-Methyl Butanal <sup>*</sup>	--	--	--	--	--	--	--
3-Nitroaniline	--	--	--	5.71E-05	h	--	5.71E-05
4,6-Dinitro-2-methylphenol	--	--	--	2.00E-03	l	--	2.00E-03
4-Bromophenyl-phenylether <sup>*</sup>	--	--	--	--	--	--	--
4-Chloro-3-methylphenol <sup>*</sup>	--	--	--	--	--	--	--
4-Chloroaniline	--	--	--	4.00E-03	a	--	4.00E-03
4-Chlorophenyl-phenylether <sup>*</sup>	--	--	--	--	--	--	--
4-Methyl-2-Pentanone	--	--	--	8.00E-02	b	--	2.29E-02
4-Methylphenol	C	--	--	5.00E-03	b	--	5.00E-03
4-Nitroaniline	--	--	--	5.71E-05	i	--	5.71E-05
4-Nitrophenol	D	--	--	8.00E-03	e	--	8.00E-03
Acenaphthene	--	--	--	6.00E-02	a	--	6.00E-02
Acenaphthylene	D	--	--	6.00E-02	j	--	6.00E-02
Acetone	D	--	--	1.00E-01	a	--	1.00E-01
Acetonitrile	--	--	--	6.00E-03	a	--	1.70E-02
Acrolein	C	--	--	2.00E-02	b	--	5.71E-06
Acrylonitrile	B1	5.40E-01	a	1.00E-03	b	2.38E-01	a
						5.71E-04	a
						1.40E-03	

Table D-2. Summary of Toxicity Factors for Non-Radiological Parameters.

Fate and Transport Modeling Results and Summary Report

ICDF

Chemical Name	Weight of Evidence Class	SFo (mg/kg-day) <sup>-1</sup>	Source	RfDo (mg/kg-day)	Source	SFi (mg/kg-day) <sup>-1</sup>	Source	RfDi day)	Source	Kp
Anthracene	D	--	--	3.00E-01	a	--	--	3.00E-01	d	2.20E-01
Aramite	B2	2.50E-02	a	5.00E-02	b	2.49E-02	a	5.00E-02	d	4.60E-02
Aroclor-1016	B2	7.00E-02	a	7.00E-05	a	7.00E-02	a	7.00E-05	d	7.90E-01
Aroclor-1254	B2	2.00E+00	a	2.00E-05	a	2.00E+00	a	2.00E-05	d	3.50E-01
Aroclor-1260	--	2.00E+00	a	--	--	2.00E+00	a	--	--	1.10E+00
Aroclor-1268	--	2.00E+00	o	--	--	2.00E+00	o	--	--	1.10E+00
Benzene	A	5.50E-02	a	3.00E-03	e	2.70E-02	a	1.71E-03	e	2.10E-02
Benzidine	A	2.30E+02	a	3.00E-03	a	2.30E+02	a	3.00E-03	d	1.30E-03
Benzo(a)anthracene	B2	7.30E-01	e	--	--	3.10E-01	e	--	--	8.10E-01
Benzo(a)pyrene	B2	7.30E+00	a	--	--	3.10E+00	e	--	--	1.20E+00
Benzo(b)fluoranthene	B2	7.30E-01	e	--	--	3.10E-01	e	--	--	1.20E+00
Benzo(g,h,i)perylene	D	--	--	3.00E-02	k	--	--	3.00E-02	k	1.80E+00
Benzo(k)fluoranthene	B2	7.30E-02	e	--	--	3.10E-02	e	--	--	6.00E-01
Benzoic acid	D	--	--	4.00E+00	a	--	--	4.00E+00	d	7.30E-03
bis(2-Chloroethoxy)methane*	--	--	--	--	--	--	--	--	--	1.40E-03
bis(2-Chloroethyl)ether	B2	1.10E+00	a	--	--	1.16E+00	a	--	--	2.10E-03
bis(2-Chloroisopropyl)ether	C	7.00E-02	b	4.00E-02	a	3.50E-02	b	4.00E-02	d	1.20E-02
bis(2-Ethylhexyl)phthalate	B2	1.40E-02	a	2.00E-02	a	1.40E-02	e	2.20E-02	d	3.30E-02
D-7	Butane,1,1,3,4-Tetrachloro-	--	--	--	--	--	--	--	--	--
Butylbenzylphthalate	C	--	--	2.00E-01	a	--	--	2.00E-01	d	7.10E-02
Carbazole	B2	2.00E-02	b	--	--	2.00E-02	d	--	--	9.10E-02
Carbon Disulfide	--	--	--	1.00E-01	a	--	--	2.00E-01	a	2.40E-02
Chlorobenzene	D	--	--	2.00E-02	a	--	--	1.70E-02	e	4.10E-02
Chloroethane	--	2.90E-03	e	4.00E-01	e	2.90E-03	e	2.86E+00	a	8.00E-03
Chloromethane	C	1.30E-02	b	--	--	6.30E-03	b	8.60E-02	e	4.20E-03
Chrysene	B2	7.30E-03	e	--	--	3.10E-03	e	--	--	8.10E-03
Decane, 3,4-Dimethyl'	--	--	--	--	--	--	--	--	--	--
Diacetone alcohol'	--	--	--	--	--	--	--	--	--	--
Dibenz(a,h)anthracene	B2	7.30E+00	e	--	--	3.10E+00	e	--	--	2.70E+00
Dibenzofuran	D	--	--	4.00E-03	e	--	--	4.00E-03	d	1.50E-01
Diethylphthalate	D	--	--	8.00E-01	a	--	--	8.00E-01	d	4.80E-03
Dimethyl Disulfide*	--	--	--	--	--	--	--	--	--	--
Dimethylphthalate	D	--	--	1.00E+01	a	--	--	1.00E+01	d	1.60E-03
Di-n-butylphthalate	D	--	--	1.00E-01	a	--	--	1.00E-01	d	3.30E-02
Di-n-octylphthalate	--	--	--	2.00E-02	b	--	--	2.00E-02	d	2.70E+01
Eicosane*	--	--	--	--	--	--	--	--	--	--
Ethyl cyanide*	--	--	--	--	--	--	--	--	--	--
Ethylbenzene	D	--	--	1.00E-01	a	--	--	2.90E-01	a	7.40E-02
Famphur*	--	--	--	--	--	--	--	--	--	--
Fluoranthene	D	--	--	4.00E-02	a	--	--	4.00E-02	d	3.60E-01
Fluorene	D	--	--	4.00E-02	a	--	--	4.00E-02	d	2.50E-01
Heptadecane, 2,6,10,15-Tetra*	--	--	--	--	--	--	--	--	--	--
Hexachlorobenzene	B2	1.60E+00	a	8.00E-04	a	1.61E+00	a	8.00E-04	d	2.10E-01
Hexachlorobutadiene	C	7.80E-02	a	3.00E-04	e	7.80E-02	a	3.00E-04	d	1.20E-01
Hexachlorocyclopentadiene	D	--	--	7.00E-03	a	--	--	2.00E-05	b	2.90E-02

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Chemical Name	Weight of Evidence Class	SFo (mg/kg-day) <sup>-1</sup>	Source	RfDo (mg/kg-day)	Source	SFi (mg/kg-day) <sup>-1</sup>	Source	RfDi day)	Source	Kp
Hexachloroethane	C	1.40E-02	a	1.00E-03	a	1.40E-02	a	1.00E-03	d	4.20E-02
Indeno(1,2,3-cd)pyrene	B2	7.30E-01	e	--	--	3.10E-01	e	--	--	1.90E+00
Isobutyl alcohol	--	--	--	3.00E-01	a	--	--	3.00E-01	d	2.60E-03
Isophorone	C	9.50E-04	a	2.00E-01	a	9.50E-04	e	2.00E-01	d	4.40E-03
Isopropyl Alcohol/2-propanol*	--	--	--	--	--	--	--	--	--	8.90E-04
Kepone	--	1.80E+01	e	--	--	1.80E+01	d	--	--	--
Mesityl oxide*	--	--	--	--	--	--	--	--	--	--
Methyl Acetate	--	--	--	1.00E+00	b	--	--	1.00E+00	d	9.00E-04
Methylene Chloride	B2	7.50E-03	a	6.00E-02	a	1.65E-03	a	8.57E-01	b	4.50E-03
Naphthalene	C	--	--	2.00E-02	a	--	--	8.57E-04	a	6.90E-02
Nitrobenzene	B2	--	--	5.00E-04	a	--	--	5.71E-04	b	6.90E-03
N-Nitroso-di-n-propylamine	B2	7.00E+00	a	--	--	7.00E+00	d	--	--	2.80E-03
N-Nitrosodiphenylamine	B2	4.90E-03	a	--	--	4.90E-03	d	--	--	3.60E-02
Octane,2,3,7-Trimethyl*	--	--	--	--	--	--	--	--	--	--
o-Toluenesulfonamide*	--	--	--	--	--	--	--	--	--	--
Pentachlorophenol	B2	1.20E-01	a	3.00E-02	a	1.20E-01	d	3.00E-02	d	6.50E-01
Phenanthrene	D	--	--	3.00E-01	a	--	--	3.00E-01	d	2.70E-01
Phenol	D	--	--	6.00E-01	a	--	--	6.00E-01	d	5.50E-03
D <sub>8</sub> Phenol,2,6-Bis(1,1-Dimethyl)*	--	--	--	--	--	--	--	--	--	--
p-Toluenesulfonamide*	--	--	--	--	--	--	--	--	--	--
Pyrene	D	--	--	3.00E-02	a	--	--	3.00E-02	d	3.20E-01
Styrene	C	--	--	2.00E-01	a	--	--	2.90E-01	a	5.50E-02
Tetrachloroethene	C-B2	5.20E-02	e	1.00E-02	a	2.03E-03	e	1.14E-01	e	4.80E-02
Toluene	D	--	--	2.00E-01	a	--	--	1.10E-01	b	4.50E-02
Tributylphosphate*	--	--	--	--	--	--	--	--	--	--
Trichloroethene	B2	1.10E-02	e	6.00E-03	a	6.00E-03	e	6.00E-03	d	1.60E-02
Undecane,4,6-Dimethyl-*	--	--	--	--	--	--	--	--	--	--
Xylene (ortho)	--	--	--	2.00E+00	a	--	--	2.00E-01	a	8.00E-02
Xylene (total)	D	--	--	2.00E+00	a	--	--	2.00E-01	a	8.00E-02
Trinitrotoluene	--	3.00E-02	a	5.00E-04	a	3.00E-02	d	5.00E-04	d	1.60E-02
RDX	--	1.10E-01	a	3.00E-03	a	1.10E-01	d	3.00E-03	d	1.90E-02
Aluminum	--	--	--	1.00E+00	e	--	--	1.40E-03	e	1.00E-03
Antimony	D	--	--	4.00E-04	a	--	--	--	--	1.00E-03
Arsenic	A	1.50E+00	a	3.00E-04	a	1.51E+01	a	--	--	1.00E-03
Barium	D	--	--	7.00E-02	a	--	--	1.43E-04	b	1.00E-03
Beryllium	B1	--	--	2.00E-03	a	8.40E+00	a	5.71E-06	a	1.00E-03
Boron	D	--	--	9.00E-02	a	--	--	5.71E-03	b	1.00E-03
Cadmium	B1	--	--	5.00E-04	a	6.30E+00	a	--	--	1.00E-03
Calcium*	--	--	--	--	--	--	--	--	--	1.00E-03
Chloride*	--	--	--	--	--	--	--	--	--	1.00E-03
Chromium	A	--	--	--	--	4.20E+01	a	--	--	1.00E-03
Cobalt	--	--	--	6.00E-02	e	--	--	--	--	1.00E-03
Copper	D	--	--	3.71E-02	b	--	--	--	--	1.00E-03
Cyanide	--	--	--	2.00E-02	a	--	--	8.57E-04	a	--
Dysprosium	--	--	--	2.00E-01	e	--	--	--	--	--
Fluoride	--	--	--	6.00E-02	a	--	--	--	--	--

Table D-2. Summary of Toxicity Factors for Non-Radiological Parameters.  
 Fate and Transport Modeling Results and Summary Report  
 ICDF

Chemical Name	Weight of Evidence Class	SFO (mg/kg-day) <sup>-1</sup>	Source	RfDo (mg/kg-day)	Source	SFI (mg/kg-day) <sup>-1</sup>	Source	RfDi day)	Source	Kp
Iron	--	--	--	3.00E-01	e	--	--	--	--	1.00E-03
Lead*	--	--	--	--	--	--	--	--	--	1.00E-03
Magnesium*	--	--	--	--	--	--	--	--	--	1.00E-03
Manganese	D	--	--	2.40E-02	a	--	--	1.40E-05	a	1.00E-03
Mercury	D	--	--	3.00E-04	a	--	--	--	--	1.00E-03
Molybdenum	--	--	--	5.00E-03	b	--	--	--	--	1.00E-03
Nickel	D	--	--	2.00E-02	a	--	--	--	--	1.00E-03
Nitrate*	--	--	--	--	--	--	--	--	--	--
Nitrate/Nitrite-N*	--	--	--	--	--	--	--	--	--	--
Nitrite*	--	--	--	--	--	--	--	--	--	--
Phosphorus*	--	--	--	--	--	--	--	--	--	1.00E-03
Potassium*	--	--	--	--	--	--	--	--	--	1.00E-03
Selenium	D	--	--	5.00E-03	a	--	--	--	--	1.00E-03
Silver	D	--	--	5.00E-03	a	--	--	--	--	1.00E-03
Sodium*	--	--	--	--	--	--	--	--	--	1.00E-03
Strontium	--	--	--	6.00E-01	a	--	--	--	--	1.00E-03
Sulfate*	--	--	--	--	--	--	--	--	--	--
Sulfide*	--	--	--	--	--	--	--	--	--	--
Terbium*	--	--	--	--	--	--	--	--	--	1.00E-03
Thallium	D	--	--	6.60E-05	a	--	--	--	--	1.00E-03
Vanadium	--	--	--	7.00E-03	b	--	--	--	--	1.00E-03
Ytterbium*	--	--	--	--	--	--	--	--	--	1.00E-03
Zinc	D	--	--	3.00E-01	a	--	--	--	--	1.00E-03
Zirconium*	--	--	--	--	--	--	--	--	--	1.00E-03

- Notes:
- a. US EPA. The Integrated Risk Information System (IRIS, 2000), a database available through the EPA National Center for Environmental Assessment (NCEA). <http://www.epa.gov/iris/>
  - b. US EPA. Health Effects Assessment Summary Tables (HEAST) FY 1997 Update. EPA-540-R-97-036. July 1997.
  - c. US EPA Region III RBC Tables. April 1999. <http://www.epa/reg3hwmd/risk/>
  - d. Route to route extrapolation
  - e. US EPA Region IX Preliminary Remediation Goals Table. November 22, 2000. [http://www.epa.gov/region09/waste/sfund/prg/s1\\_01.htm](http://www.epa.gov/region09/waste/sfund/prg/s1_01.htm)
  - f. Oak Ridge National Laboratory. October 2001. [http://risk.lsd.ornl.gov/rap\\_hp.shtml](http://risk.lsd.ornl.gov/rap_hp.shtml)
  - g. Toxicity factors for 4-nitrophenol were used as surrogates for 2-nitrophenol
  - h. Toxicity factors for 2-nitroaniline were used as surrogates for 3-nitroaniline
  - i. Toxicity factors for 2-nitroaniline were used as surrogates for 4-nitroaniline
  - j. Toxicity factors for acenaphthene were used as surrogates for acenaphthylene
  - k. Toxicity factors for pyrene were used as surrogates for benzo(g,h,i)perylene
  - l. Toxicity factors for 2,4-dintrophenol were used as surrogates for 4,6-dinitro-2-methylphenol.
  - m. US EPA Risk Assessment Guidance for Superfund Volume I: Human Health Evaluation Manual Supplemental Guidance Dermal Risk Assessment. November 6, 1998.
  - n. U. S. Environmental Protection Agency. 1996. Superfund Soil Screening Guidance: User's Guide, Second Edition. Office of Solid Waste and Emergency Response Publication 9355.4-35
  - o. Toxicity factors for aroclor 1260 were used as surrogates for aroclor 1268.
  - p. EPA. Dermal Exposure Assessment: Principles and Applications. Interim Report. EPA/600/8-91/011B. January 1992
- \* No toxicity factors available for this chemical

Table D-2. Summary of Toxicity Factors for Non-Radiological Parameters.

Fate and Transport Modeling Results and Summary Report

ICDF

Chemical Name	Weight of Evidence Class	SFo (mg/kg-day) <sup>-1</sup>	RfDo Source	(mg/kg-day)	SFi (mg/kg-day) <sup>-1</sup>	RfDi day)	Source	Kp
-- = not applicable or not available								

Table D-3. Summary of Toxicity Factors for Radiological Parameters.  
 Fate and Transport Modeling Results and Summary Report  
 ICDF

Isotope <sup>a</sup>	Oral Slope Factor (risk/pCi) <sup>b,c</sup>	Kp <sup>d</sup>
Ac225	--	1.00E-03
Ac227	5.59E-12	1.00E-03
Ac228	1.89E-10	1.00E-03
Ag106	6.92E-11	6.00E-04
Ag108	2.01E-10	6.00E-04
Ag108m	4.86E-10	6.00E-04
Ag109m	1.99E-12	6.00E-04
Ag110	7.25E-14	6.00E-04
Ag110m	1.20E-13	6.00E-04
Ag111	1.65E-13	6.00E-04
Am241	1.21E-13	1.00E-03
Am242	1.77E-12	1.00E-03
Am242m	5.92E-14	1.00E-03
Am243	4.81E-12	1.00E-03
Am245	-	1.00E-03
Am246	8.14E-12	1.00E-03
At217	-	1.00E-03
Ba136m	-	1.00E-03
Ba137m	9.88E-12	1.00E-03
Ba140	8.21E-12	1.00E-03
Be 10	1.99E-12	1.00E-03
Bi210	1.40E-13	1.00E-03
Bi211	1.73E-11	1.00E-03
Bi212	-	1.00E-03
Bi213	5.07E-14	1.00E-03
Bi214	9.62E-14	1.00E-03
Bk249	1.38E-12	1.00E-03
Bk250	2.59E-12	1.00E-03
C 14	1.04E-10	1.00E-03
Cd109	1.79E-12	1.00E-03
Cd113m	7.07E-11	1.00E-03
Cd115m	1.04E-10	1.00E-03
Ce141	1.03E-10	1.00E-03
Ce142	1.08E-10	1.00E-03
Ce144	2.52E-12	1.00E-03
Cf249	5.11E-14	1.00E-03
Cf250	2.22E-13	1.00E-03
Cf251	1.23E-13	1.00E-03
Cf252	6.59E-14	1.00E-03
Cm241	-	1.00E-03
Cm242	-	1.00E-03
Cm243	-	1.00E-03
Cm244	1.05E-13	1.00E-03
Cm245	3.20E-13	1.00E-03
Cm246	2.28E-12	1.00E-03
Cm247	1.02E-11	1.00E-03
Cm248	1.56E-12	1.00E-03
Cm250	6.70E-12	1.00E-03
Co-57	9.66E-12	4.00E-04
Co-58	2.50E-12	4.00E-04
Co-60	6.33E-13	4.00E-04
Cr-51	6.96E-13	1.00E-03
Cs132	3.37E-11	1.00E-03
Cs134	-	1.00E-03
Cs135	-	1.00E-03
Cs136	-	1.00E-03
Cs137	-	1.00E-03
Er169	7.36E-13	1.00E-03
Eu150	1.66E-12	1.00E-03
Eu152	1.50E-12	1.00E-03
Eu154	-	1.00E-03
Eu155	6.29E-12	1.00E-03
Eu156	7.44E-12	1.00E-03
Fe-59	2.78E-12	1.00E-03
Fr221	1.55E-13	1.00E-03
Fr223	5.44E-12	1.00E-03

Table D-3. Summary of Toxicity Factors for Radiological Parameters.

Fate and Transport Modeling Results and Summary Report

ICDF

Isotope <sup>a</sup>	Oral Slope Factor (risk/pCi) <sup>b,c</sup>	Kp <sup>d</sup>
Gd152	4.33E-14	1.00E-03
Gd153	8.51E-13	1.00E-03
H-3	1.52E-11	1.00E-03
Hf-181	2.00E-12	1.00E-03
Ho166m	9.25E-15	1.00E-03
I-129	6.81E-12	1.00E-03
I-131	3.19E-12	1.00E-03
In-114	2.56E-12	1.00E-03
In-114m	-	1.00E-03
In-115	3.70E-13	1.00E-03
In-115m	1.49E-11	1.00E-03
K-40	2.14E-13	2.00E-04
Kr-81	9.29E-14	1.00E-03
Kr-85	7.03E-12	1.00E-03
La-138	8.66E-14	1.00E-03
La-140	1.52E-13	1.00E-03
Mn-54	4.22E-13	1.00E-03
Nb-93m	2.65E-13	1.00E-03
Nb-94	1.92E-12	1.00E-03
Nb-92	3.32E-12	1.00E-03
Nb-95	7.73E-12	1.00E-03
Nb-95m	5.66E-12	1.00E-03
Nd-144	8.92E-12	1.00E-03
Nd-147	5.51E-11	1.00E-03
Np-235	-	1.00E-03
Np-236	7.10E-13	1.00E-03
Np-237	5.11E-13	1.00E-03
Np-238	1.92E-13	1.00E-03
Np-239	3.43E-12	1.00E-03
Np-240	2.01E-12	1.00E-03
Np-240m	1.24E-10	1.00E-03
Pa-231	1.11E-12	1.00E-03
Pa-233	5.66E-13	1.00E-03
Pa-234	1.50E-13	1.00E-03
Pa-234m	2.46E-13	1.00E-03
Pb-209	1.57E-13	1.00E-04
Pb-210	1.45E-12	1.00E-04
Pb-211	3.01E-13	1.00E-04
Pb-212	4.70E-14	1.00E-04
Pb-214	2.82E-13	1.00E-04
Pd-107	1.71E-12	1.00E-03
Pm-146	8.44E-14	1.00E-03
Pm-147	1.48E-13	1.00E-03
Pm-148	4.07E-14	1.00E-03
Pm-148m	1.55E-12	1.00E-03
Po-210	3.53E-13	1.00E-03
Po-211	2.47E-12	1.00E-03
Po-212	7.55E-12	1.00E-03
Po-213	-	1.00E-03
Po-214	1.72E-13	1.00E-03
Po-215	3.50E-13	1.00E-03
Po-216	5.00E-12	1.00E-03
Po-218	2.28E-11	1.00E-03
Pr-143	2.87E-11	1.00E-03
Pr-144	8.66E-12	1.00E-03
Pr-144m	1.70E-11	1.00E-03
Pu-236	1.37E-12	1.00E-03
Pu-237	1.22E-12	1.00E-03
Pu-238	1.59E-11	1.00E-03
Pu-239	3.81E-12	1.00E-03
Pu-240	1.31E-13	1.00E-03
Pu-241	3.47E-12	1.00E-03
Pu-242	1.35E-12	1.00E-03
Pu-243	4.63E-12	1.00E-03
Pu-244	7.10E-12	1.00E-03
Pu-246	3.52E-11	1.00E-03

Table D-3. Summary of Toxicity Factors for Radiological Parameters.

Fate and Transport Modeling Results and Summary Report

ICDF

Isotope <sup>a</sup>	Oral Slope Factor (risk/pCi) <sup>b,c</sup>	K <sub>p</sub> <sup>d</sup>
Ra222	3.53E-11	1.00E-03
Ra223	1.25E-13	1.00E-03
Ra224	2.11E-11	1.00E-03
Ra225	4.44E-11	1.00E-03
Ra226	1.27E-10	1.00E-03
Ra228	8.62E-11	1.00E-03
Rb86	1.32E-10	1.00E-03
Rb87	-	1.00E-03
Rh102	4.26E-12	1.00E-03
Rh103m	-	1.00E-03
Rh106	3.30E-12	1.00E-03
Rn218	1.93E-13	1.00E-03
Rn219	1.52E-13	1.00E-03
Rn220	3.28E-13	1.00E-03
Rn222	3.49E-11	1.00E-03
Ru103	4.85E-12	1.00E-03
Ru106	3.85E-11	1.00E-03
Sb124	9.47E-11	1.00E-03
Sb125	8.36E-11	1.00E-03
Sb126	1.04E-10	1.00E-03
Sb126m	1.02E-10	1.00E-03
Sc-46	9.95E-11	1.00E-03
Se 79	-	1.00E-03
Sm146	8.40E-14	1.00E-03
Sm147	4.63E-12	1.00E-03
Sm148	1.01E-11	1.00E-03
Sm149	1.04E-12	1.00E-03
Sm151	2.95E-12	1.00E-03
Sn117m	1.26E-13	1.00E-03
Sn119m	1.57E-11	1.00E-03
Sn121m	2.66E-15	1.00E-03
Sn123	2.43E-13	1.00E-03
Sn125	8.25E-14	1.00E-03
Sn126	7.44E-13	1.00E-03
Sr89	1.35E-13	1.00E-03
Sr90	1.85E-13	1.00E-03
Tb160	5.96E-14	1.00E-03
Tb161	-	1.00E-03
Tc 98	6.51E-14	1.00E-03
Tc 99	-	1.00E-03
Te123	1.85E-13	1.00E-03
Te123m	4.74E-14	1.00E-03
Te125m	1.86E-13	1.00E-03
Te127	1.46E-12	1.00E-03
Te127m	4.22E-11	1.00E-03
Te129	4.14E-14	1.00E-03
Te129m	4.74E-12	1.00E-03
Th226	4.51E-14	1.00E-03
Th227	8.66E-12	1.00E-03
Th228	3.04E-11	1.00E-03
Th229	3.04E-11	1.00E-03
Th230	1.58E-13	1.00E-03
Th231	1.37E-13	1.00E-03
Th232	4.63E-13	1.00E-03
Th234	-	1.00E-03
Tl207	6.40E-13	1.00E-03
Tl208	-	1.00E-03
Tl209	1.94E-12	1.00E-03
Tm170	5.25E-13	1.00E-03
Tm171	2.26E-13	1.00E-03
U230	5.29E-13	1.00E-03
U232	4.14E-13	1.00E-03
U233	1.11E-11	1.00E-03
U234	3.15E-13	1.00E-03
U235	8.95E-14	1.00E-03
U236	2.53E-12	1.00E-03

Table D-3. Summary of Toxicity Factors for Radiological Parameters.

Fate and Transport Modeling Results and Summary Report

ICDF

Isotope <sup>a</sup>	Oral Slope Factor (risk/pCi) <sup>b,c</sup>	Kp <sup>d</sup>
U237	2.02E-12	1.00E-03
U238	5.99E-12	1.00E-03
U240	5.96E-14	1.00E-03
Xe127	1.02E-12	1.00E-03
Xe129m	3.49E-11	1.00E-03
Xe131m	5.51E-11	1.00E-03
Xe133	2.73E-11	1.00E-03
Y90	2.73E-12	1.00E-03
Y91	4.55E-12	1.00E-03
Zn65	2.02E-12	1.00E-03
Zr93	4.29E-12	1.00E-03
Zr95	5.14E-13	1.00E-03

Notes

a. For each radionuclide listed, slope factors correspond to the risks per unit intake or exposure for that radionuclide only, except when marked with a "+D" to indicate that the risks from associated short-lived radioactive decay products (i.e., those decay products with radioactive half-lives less than or equal to 6 months) are also included. Refer to Exhibit 1 in the User's Guide section on radionuclide carcinogenicity for guidance on determining slope factors for partial or complete radioactive decay chains.

b. The curie (Ci), the customary unit of activity is equal to  $3.7 \times 10^{10}$  nuclear transformations per second. 1 picocurie (pCi) =  $10^{-12}$  Ci. The International System (SI) unit of activity is the becquerel (1 Bq = 1 nuclear transformation per second).

c. EPA. Radiation Protection Programs, Radiation Slope Factors at the web site <http://www.epa.gov/radiation/heast/>

d. EPA guidance recommends using a default Kp of  $1 \times 10^{-3}$  cm/hr for inorganic compounds unless otherwise noted. Source: Risk Assessment Guidance for Superfund Volume I: Human Health Evaluation Manual, Supplemental Guidance, Dermal Risk Assessment, Interim Guidance, EPA, November 6, 1998..

For radioisotopes of iodine, the values listed for food ingestion represent ingestion of milk; corresponding values for ingestion of nondairy foods would be lower by a factor of approximately 2.

For radioisotopes of mercury, Federal Guidance Report No. 13 provides values for inorganic compounds, organic compounds, and methyl mercury for ingestion of each isotope. The ingestion values reported in Table 4 for each isotope represent the maximum of these three forms.

For radioisotopes of polonium, Federal Guidance Report No. 13 provides values for ingestion of organic ( $f_1=0.5$ ) and inorganic ( $f_1=0.1$ ) compounds. For purposes of this tabulation, polonium is assumed to be ingested in organic form in foods and in inorganic form in water and soil.

For radioisotopes of sulfur, Federal Guidance Report No. 13 provides values for ingestion of both organic and inorganic compounds. For the purpose of this tabulation, sulfur is assumed to be ingested in organic form in foods and in inorganic form for ingestion of water and soil.

Table D-4. Summary of Groundwater Carcinogenic RBCs for Non-Radiological Parameters.  
 Residential Exposure Scenario  
 ICDF

Chemical	Individual RBC (mg/L)	Cumulative RBC (mg/L)
1,1,2,2-Tetrachloroethane	5.52E-03	1.72E-04
1,1,2-Trichloroethane	1.99E-02	6.22E-04
1,1-Dichloroethene	4.50E-03	1.41E-04
1,4-Dichlorobenzene	4.92E-02	1.54E-03
1,4-Dioxane	6.11E-01	1.91E-02
2,4,6-Trichlorophenol	5.60E-01	1.75E-02
3,3'-Dichlorobenzidine	1.45E-02	4.53E-04
Aramite	2.48E-01	7.75E-03
Aroclor-1260	1.11E-03	3.48E-05
Aroclor-1268	1.11E-03	3.48E-05
Benzidine	2.92E-05	9.11E-07
Benzo(a)anthracene	3.71E-03	1.16E-04
Benzo(a)pyrene	2.88E-04	8.99E-06
Benzo(b)fluoranthene	2.88E-03	8.99E-05
Benzo(k)fluoranthene	4.38E-02	1.37E-03
bis(2-Chloroethyl)ether	9.77E-04	3.05E-05
bis(2-Chloroisopropyl)ether	2.73E-02	8.52E-04
bis(2-Ethylhexyl)phthalate	4.53E-01	1.42E-02
Carbazole	2.88E-01	9.00E-03
Chloroethane	3.85E-01	1.20E-02
Chloromethane	1.51E-01	4.71E-03
Chrysene	9.08E-01	2.84E-02
Dibenz(a,h)anthracene	1.55E-04	4.84E-06
Hexachlorobenzene	3.03E-03	9.48E-05
Indeno(1,2,3-cd)pyrene	2.05E-03	6.42E-05
Methylene Chloride	4.26E-01	1.33E-02
N-Nitroso-di-n-propylamine	9.56E-04	2.99E-05
N-Nitrosodiphenylamine	1.29E+00	4.02E-02
Pentachlorophenol	2.56E-02	7.99E-04
Tetrachloroethene	1.01E-01	3.15E-03
RDX	5.91E-02	1.85E-03
Arsenic	4.47E-03	1.40E-04

Number of Samples

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Table D-5. Summary of Groundwater Noncarcinogenic RBCs for Non-Radiological Parameters.  
 Residential Exposure Scenario  
 ICDF

Chemical	Individual RBC (mg/L)	Cumulative RBC (mg/L)
1,1,1-Trichloroethane	4.17E-01	4.80E-03
1,1-Dichloroethane	6.38E-01	7.33E-03
1,2,4-Trichlorobenzene	1.40E-01	1.61E-03
1,2-Dichlorobenzene	2.89E-01	3.32E-03
1,2-Dichloroethane	7.99E-03	9.19E-05
1,2-Dichloroethene (total)	4.79E-02	5.50E-04
1,3-Dichlorobenzene	4.21E-03	4.84E-05
2,4,5-Trichlorophenol	2.60E+00	2.99E-02
2,4-Dichlorophenol	8.29E-02	9.53E-04
2,4-Dimethylphenol	5.61E-01	6.45E-03
2,4-Dinitrophenol	5.74E-02	6.60E-04
2,4-Dinitrotoluene	5.72E-02	6.58E-04
2,6-Dinitrotoluene	2.87E-02	3.30E-04
2-Butanone	1.50E+00	1.73E-02
2-Chloronaphthalene	3.66E-01	4.21E-03
2-Chlorophenol	2.39E-02	2.75E-04
2-Hexanone	1.14E+00	1.31E-02
2-Methylnaphthalene	4.52E-01	5.19E-03
2-Methylphenol	1.41E+00	1.63E-02
2-Nitroaniline	2.74E-04	3.15E-06
2-Nitrophenol	2.28E-01	2.63E-03
3-Nitroaniline	2.74E-04	3.15E-06
4,6-Dinitro-2-methylphenol	5.66E-02	6.51E-04
4-Chloroaniline	1.09E-01	1.25E-03
4-Methyl-2-Pentanone	1.25E-01	1.43E-03
4-Methylphenol	1.41E-01	1.63E-03
4-Nitroaniline	2.74E-04	3.15E-06
4-Nitrophenol	2.28E-01	2.62E-03
Acenaphthene	2.68E-01	3.08E-03
Acenaphthylene	2.80E-01	3.22E-03
Acetone	4.80E-01	5.52E-03
Acetonitrile	6.25E-02	7.19E-04
Acrolein	3.29E-05	3.79E-07
Acrylonitrile	2.95E-03	3.40E-05
Anthracene	1.35E+00	1.55E-02
Aroclor-1016	8.24E-04	9.47E-06
Aroclor-1254	3.51E-04	4.03E-06
Benzene	8.81E-03	1.01E-04
Benzo(g,h,i)perylene	2.01E-01	2.31E-03
Benzoic acid	1.14E+02	1.31E+00
Butylbenzylphthalate	5.10E+00	5.86E-02
Carbon Disulfide	8.13E-01	9.35E-03
Chlorobenzene	8.28E-02	9.52E-04
Dibenzofuran	1.84E-02	2.11E-04
Diethylphthalate	2.29E+01	2.63E-01

Table D-5. Summary of Groundwater Noncarcinogenic RBCs for Non-Radiological Parameters.  
 Residential Exposure Scenario  
 ICDF

Chemical	Individual RBC (mg/L)	Cumulative RBC (mg/L)
Dimethylphthalate	2.87E+02	3.30E+00
Di-n-butylphthalate	4.75E-01	5.47E-03
Di-n-octylphthalate	1.04E-02	1.19E-04
Ethylbenzene	1.01E+00	1.16E-02
Fluoranthene	6.94E-01	7.98E-03
Fluorene	7.90E-01	9.08E-03
Hexachlorobutadiene	7.09E-03	8.14E-05
Hexachlorocyclopentadiene	1.92E-01	2.20E-03
Hexachloroethane	2.68E-02	3.08E-04
Isobutyl alcohol	8.60E+00	9.89E-02
Isophorone	5.72E+00	6.57E-02
Methyl Acetate	4.80E+00	5.52E-02
Naphthalene	4.89E-03	5.62E-05
Nitrobenzene	2.67E-03	3.07E-05
Phenanthrene	5.78E+00	6.65E-02
Phenol	1.71E+01	1.97E-01
Pyrene	5.45E-01	6.26E-03
Styrene	1.27E+00	1.46E-02
Toluene	5.66E-01	6.51E-03
Trichloroethene	2.87E-02	3.30E-04
Xylene (ortho)	1.13E+00	1.30E-02
Xylene (total)	1.13E+00	1.30E-02
Trinitrotoluene	1.40E-02	1.61E-04
Aluminum	2.88E+01	3.31E-01
Antimony	1.14E-02	1.31E-04
Barium	1.97E+00	2.26E-02
Beryllium	4.57E-02	5.25E-04
Boron	2.59E+00	2.98E-02
Cadmium	1.39E-02	1.60E-04
Cobalt	1.73E+00	1.98E-02
Copper	1.07E+00	1.23E-02
Iron	8.63E+00	9.92E-02
Manganese	6.71E-01	7.71E-03
Mercury	8.42E-03	9.68E-05
Molybdenum	1.44E-01	1.65E-03
Nickel	5.51E-01	6.33E-03
Selenium	1.44E-01	1.65E-03
Silver	1.38E-01	1.58E-03
Strontium	1.73E+01	1.98E-01
Thallium	1.90E-03	2.18E-05
Vanadium	1.88E-01	2.17E-03
Zinc	8.63E+00	9.92E-02

Table D-6. Summary of Groundwater Carcinogenic RBCs for Radiological Parameters.  
 Residential Exposure Scenario  
 ICDF

Chemical	Individual RBC (mg/L)	Cumulative RBC (mg/L)
Ac225	2.79E+01	1.66E-01
Ac227	2.63E+01	1.56E-01
Ac228	2.65E+03	1.58E+01
Ag106	8.93E+04	5.31E+02
Ag108	--	--
Ag108m	6.49E+02	3.86E+00
Ag109m	--	--
Ag110	--	--
Ag110m	5.35E+02	3.18E+00
Ag111	6.44E+02	3.83E+00
Am241	5.08E+01	3.02E-01
Am242	2.95E+03	1.76E+01
Am242m	7.47E+01	4.45E-01
Am243	5.13E+01	3.05E-01
Am245	2.38E+04	1.42E+02
Am246	4.29E+04	2.56E+02
At217	--	--
Ba136m	--	--
Ba137m	--	--
Ba140	3.54E+02	2.11E+00
Be 10	7.51E+02	4.47E+00
Bi210	5.92E+02	3.52E+00
Bi211	--	--
Bi212	7.44E+03	4.43E+01
Bi213	1.03E+04	6.15E+01
Bi214	2.75E+04	1.64E+02
Bk249	4.76E+03	2.83E+01
Bk250	9.33E+03	5.55E+01
C 14	3.41E+03	2.03E+01
Cd109	1.06E+03	6.29E+00
Cd113m	1.84E+02	1.10E+00
Cd115m	3.11E+02	1.85E+00
Ce141	1.14E+03	6.79E+00
Ce142	--	--
Ce144	1.50E+02	8.93E-01
Cf249	4.16E+01	2.47E-01
Cf250	6.13E+01	3.65E-01
Cf251	4.00E+01	2.38E-01
Cf252	--	--
Cm241	1.09E+03	6.48E+00
Cm242	1.37E+02	8.16E-01
Cm243	5.58E+01	3.32E-01
Cm244	6.32E+01	3.76E-01
Cm245	5.08E+01	3.02E-01
Cm246	5.18E+01	3.08E-01

Table D-6. Summary of Groundwater Carcinogenic RBCs for Radiological Parameters.  
 Residential Exposure Scenario  
 ICDF

Chemical	Individual RBC (mg/L)	Cumulative RBC (mg/L)
Cm247	5.31E+01	3.16E-01
Cm248	--	--
Cm250	--	--
Co-57	5.08E+03	3.03E+01
Co-58	1.79E+03	1.07E+01
Co-60	3.37E+02	2.00E+00
Cr-51	2.85E+04	1.70E+02
Cs132	3.62E+03	2.15E+01
Cs134	1.25E+02	7.45E-01
Cs135	1.11E+03	6.63E+00
Cs136	6.10E+02	3.63E+00
Cs137	1.74E+02	1.03E+00
Er169	2.09E+03	1.24E+01
Eu150	2.22E+03	1.32E+01
Eu152	8.70E+02	5.18E+00
Eu154	5.13E+02	3.05E+00
Eu155	2.78E+03	1.65E+01
Eu156	4.16E+02	2.47E+00
Fe-59	6.70E+02	3.99E+00
Fr221	--	--
Fr223	7.24E+02	4.31E+00
Gd152	1.78E+02	1.06E+00
Gd153	3.47E+03	2.07E+01
H-3	1.04E+05	6.20E+02
Hf-181	8.30E+02	4.94E+00
Ho166m	5.73E+02	3.41E+00
I-129	3.57E+01	2.12E-01
I-131	1.16E+02	6.91E-01
In-114	--	--
In-114m	2.13E+02	1.27E+00
In-115	1.56E+02	9.30E-01
In-115m	1.20E+04	7.14E+01
K-40	2.14E+02	1.27E+00
Kr81	--	--
Kr85	--	--
La138	1.50E+03	8.90E+00
La140	4.80E+02	2.86E+00
Mn-54	2.32E+03	1.38E+01
Nb93m	6.58E+03	3.91E+01
Nb94	6.80E+02	4.04E+00
Nb92	--	--
Nb95	2.16E+03	1.28E+01
Nb95m	1.44E+03	8.59E+00
Nd144	--	--
Nd147	7.59E+02	4.52E+00

Table D-6. Summary of Groundwater Carcinogenic RBCs for Radiological Parameters.  
 Residential Exposure Scenario  
 ICDF

Chemical	Individual RBC (mg/L)	Cumulative RBC (mg/L)
Np235	1.53E+04	9.08E+01
Np236	5.03E+02	2.99E+00
Np237	8.54E+01	5.09E-01
Np238	9.78E+02	5.82E+00
Np239	1.03E+03	6.11E+00
Np240	2.37E+04	1.41E+02
Np240m	--	--
Pa231	3.05E+01	1.82E-01
Pa233	9.51E+02	5.66E+00
Pa234	2.06E+03	1.23E+01
Pa234m	--	--
Pb209	2.19E+04	1.31E+02
Pb210	6.00E+00	3.57E-02
Pb211	1.29E+04	7.66E+01
Pb212	2.12E+02	1.26E+00
Pb214	1.54E+04	9.15E+01
Pd107	2.11E+04	1.26E+02
Pm146	1.26E+03	7.52E+00
Pm147	3.12E+03	1.86E+01
Pm148	3.07E+02	1.83E+00
Pm148m	6.61E+02	3.93E+00
Po210	1.40E+01	8.34E-02
Po211	--	--
Po212	--	--
Po213	--	--
Po214	--	--
Po215	--	--
Po216	--	--
Po218	--	--
Pr143	6.67E+02	3.97E+00
Pr144	6.52E+04	3.88E+02
Pr144m	--	--
Pu236	7.07E+01	4.21E-01
Pu237	9.15E+03	5.45E+01
Pu238	4.03E+01	2.40E-01
Pu239	3.91E+01	2.33E-01
Pu240	3.91E+01	2.33E-01
Pu241	3.00E+03	1.79E+01
Pu242	4.12E+01	2.46E-01
Pu243	1.11E+04	6.63E+01
Pu244	3.85E+01	2.29E-01
Pu246	3.05E+02	1.82E+00
Ra222	--	--
Ra223	2.22E+01	1.32E-01
Ra224	3.16E+01	1.88E-01

Table D-6. Summary of Groundwater Carcinogenic RBCs for Radiological Parameters.  
 Residential Exposure Scenario  
 ICDF

Chemical	Individual RBC (mg/L)	Cumulative RBC (mg/L)
Ra225	4.63E+01	2.76E-01
Ra226	1.37E+01	8.16E-02
Ra228	5.08E+00	3.02E-02
Rb86	5.34E+02	3.18E+00
Rb87	1.01E+03	6.02E+00
Rh102	6.86E+02	4.08E+00
Rh103m	5.62E+05	3.34E+03
Rh106	--	--
Rn218	--	--
Rn219	--	--
Rn220	--	--
Rn222	--	--
Ru103	1.37E+03	8.16E+00
Ru106	1.25E+02	7.45E-01
Sb124	4.09E+02	2.44E+00
Sb125	1.21E+03	7.19E+00
Sb126	4.76E+02	2.83E+00
Sb126m	7.93E+04	4.72E+02
Sc-46	8.49E+02	5.05E+00
Se 79	7.24E+02	4.31E+00
Sm146	1.28E+02	7.65E-01
Sm147	1.41E+02	8.40E-01
Sm148	--	--
Sm149	--	--
Sm151	9.51E+03	5.66E+01
Sn117m	1.21E+03	7.19E+00
Sn119m	2.39E+03	1.42E+01
Sn121m	2.26E+03	1.34E+01
Sn123	3.77E+02	2.24E+00
Sn125	2.63E+02	1.56E+00
Sn126	2.06E+02	1.23E+00
Sr89	4.12E+02	2.46E+00
Sr90	9.45E+01	5.62E-01
Tb160	6.07E+02	3.61E+00
Tb161	1.11E+03	6.59E+00
Tc 98	7.44E+02	4.43E+00
Tc 99	1.92E+03	1.14E+01
Te123	1.28E+03	7.65E+00
Te123m	1.28E+03	7.59E+00
Te125m	1.59E+03	9.44E+00
Te127	5.28E+03	3.14E+01
Te127m	6.13E+02	3.65E+00
Te129	3.09E+04	1.84E+02
Te129m	3.45E+02	2.05E+00
Th226	7.93E+03	4.72E+01

Table D-6. Summary of Groundwater Carcinogenic RBCs for Radiological Parameters.  
 Residential Exposure Scenario  
 ICDF

Chemical	Individual RBC (mg/L)	Cumulative RBC (mg/L)
Th227	1.11E+02	6.63E-01
Th228	4.93E+01	2.94E-01
Th229	2.36E+01	1.40E-01
Th230	5.80E+01	3.45E-01
Th231	2.39E+03	1.42E+01
Th232	5.23E+01	3.11E-01
Th234	2.29E+02	1.36E+00
Tl207	--	--
Tl208	--	--
Tl209	--	--
Tm170	5.92E+02	3.52E+00
Tm171	7.55E+03	4.50E+01
U230	2.53E+01	1.50E-01
U232	1.81E+01	1.08E-01
U233	7.35E+01	4.38E-01
U234	7.47E+01	4.45E-01
U235	7.59E+01	4.52E-01
U236	7.88E+01	4.69E-01
U237	1.08E+03	6.44E+00
U238	8.25E+01	4.91E-01
U240	7.51E+02	4.47E+00
Xe127	--	--
Xe129m	--	--
Xe131m	--	--
Xe133	--	--
Y90	2.92E+02	1.74E+00
Y91	3.30E+02	1.96E+00
Zn65	4.51E+02	2.69E+00
Zr93	4.76E+03	2.83E+01
Zr95	1.15E+03	6.85E+00

Number of Chemicals

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